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GATEROAD DEFORMATION SURVEY OF THE SYDNEY COALFIELD: APPROACH METHODOLOGY

W.D. Gallant
Cape Breton Coal Research Laboratory

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GATEROAD DEFORMATION SURVEY OF THE SYDNEY COALFIELD: APPROACH METHODOLOGY

by

W.D. Gallant*

SUMMARY

This report describes methods used to perform a deformation survey on 35 km of gateroad in the Sydney Coalfield. Its purpose is to provide a record of procedure and technique.

Topics discussed include deformation causes and parameters of measurement, a photographic technique for recording profile, data tabulation and method of future analysis.

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*Technologist, Strata Mechanics, Cape Breton Coal Research Laboratories, CANMET, Energy, Mines and Resources Canada, Sydney.

LEVÉ DES DÉFORMATIONS DE LA VOIE DE ROULAGE DE LA HOUILLÈRE DE SYDNEY: MÉTHODOLOGIE DES APPROXIMATIONS

par

W.D. Gallant*

SOMMAIRE

Ce rapport donne une description des méthodes utilisées pour faire un levé des déformations de la voie de roulage de la houillère de Sydney sur une distance de 35 km. Il a été fait afin de fournir des renseignements sur les procédés et les techniques utilisés.

Les sujets traités comprennent les causes des déformations, les paramètres de mesure, une technique photographique d'enregistrement des profils, la classification des données et des méthodes relatives aux analyses ultérieures.

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*Technologue, Mécanique des couches géologiques, Laboratoires de recherche sur le charbon du Cap Breton, CANMET, Énergie, Mines et Ressources Canada, Sydney.

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INTRODUCTION

In the Sydney Coalfield, the Cape Breton Development Corporation (CBDC) operates two coal mines that employ longwall advancing methods: Lingan Mine and Number 26 Colliery (Figures 1 and 2). Access to the walls is by means of two gateroads, one at each end of the wall face. A barrier pillar of 60 m is left between the walls. The gateroads provide:

1. Access of men and materials to the face,
2. A ventilation supply route for the face,
3. A route for coal removal.

Geotechnical performance of the gateroad, i.e. manner and rate of deformation, affects the productivity and lifetime of the wall face. Roadway closure increases resistance to the ventilation system, restricts transportation, and if severe enough, results in a need for dinting or re-arching. Excessive roadway closure can result in decreased productivity and increased operating cost.

To protect gateroads from severe closure, CBDC has adopted a policy of leaving 60 m coal pillars between walls. Coal left in the pillar is equivalent to over 30% of the coal that could be mined. Whether the coal pillar is sufficiently wide to prevent crushing of the roadways or alternately whether an excess of coal is left causing waste of the coal resource is of great concern.

For an advancing longwall operation such as at CBDC, the optimum design must call for gateroads to remain useable for the life of the wall but also leave a minimum barrier pillar width required to support the roadway. To optimize the design of roadway support, an understanding of gateroad deformation is therefore required.

Major factors affecting roadway closure are:

1. Method of roadway support,
2. Barrier pillar width,
3. Depth of cover,
4. Geology of roof and floor,
5. Rate of advance,
6. Pack type,
7. Extracted seam height.

The purpose of a gateroad deformation study is to provide a better understanding of the deformation process, and this is best achieved by comparing gateroad performance against the previously mentioned parameters.

BACKGROUND

A survey of the study area (Number 26 Colliery and Lingan Mine, Figures 1 and 2) showed 35 km of accessible gateroad. This is a large distance and would require a quick and easy method of measuring deformation if all of the accessible area is to be examined.

During the mid sixties, H. Zorychta et al. (1) performed deformation measurements at Number 26 Colliery and other collieries owned by the Dominion Coal Company. Pins were installed in the roof and floor with measurements being taken periodically. This method required substantial set up (drilling and installation of the pins) and monitoring the stations over a period of time. This method would be prohibitively expensive and time consuming to cover 35 km of gateroad.

A more suitable method was described by Whittaker (2) in the early Seventies. This method involved the parameters of height, width, and roadway profile compared against the distance from face line. Heights are measured from the inner flange of the roadway support to the existing floor. Width is measured horizontally from one side of the arch to the other, approximately 1 m above the floor. Roadway profile is recorded by a patterned set of measurements (Figure 3). The frequency of measurements (Figure 4) would be:

1. Height and width every 10 m for the first 100 m from the face,
2. Height and width every 25 or 50 m thereafter,
3. Profile every 100 m.

Results obtained by this method would include height, width, profile and area as determined from the profile sketch. The equipment required is minimal (a tape and a notebook) and coverage could be accomplished at a fairly fast rate. The procedure outlined by Whittaker (2) was used as a model for our survey but with one major change. To record the gateroad

profile a photograph was used (Figure 5). An accurate scale measurement of the working print was used to determine the area and also the perimeter of the arch above the floor. Photographs are easy and very quick to take and also provide a record of the profile for further reference. For these reasons, this procedure was used to carry out the Gateroad Deformation Study at the Lingan Mine and Number 26 Collieries.

FIELD WORK

Data collection of the underground observations took place between June 1983 and December 1983 at the Lingan Mine and Number 26 Collieries. The work party varied from three to five people and always included one person supplied by CBDC; either a mine examiner or a ventilation technologist. The photographic equipment was approved for underground use by the Department of Energy, Mines and Resources.

The gateroads examined were as follows:

Lingan Mine - 5 East, 6 East, 7 East
2 West, 3 West, 4 West

Number 26 Colliery - 10 South top only, 12 South, 13 South,
7 North bottom only, 12 North, 13 North,
14 North

The work was carried out in the following manner:

1. The starting arch was marked 0 with chalk and every 50th arch thereafter was marked with its corresponding number. The starting arch would either be the last arch placed at the face or the arch at the outside ribline of the original face line, depending on which way the crew felt it better to work.
2. Measurements of height were taken every 10 arches with a tape and a 1 m stick from the arch (Center Line) in order to facilitate better reading of the tape (Figure 6).
3. A photograph was taken every 50th arch and the roadway width measured (Figure 6). Occasionally the photograph was taken of an arch 2 or 3 away from the 50th due to obstructions in the roadway. After the arch was selected, a chalked line was placed on the edge of the arch in order

to make it stand out in the picture. To ensure an equal scale in the photos, a 25 ft. length of rope was used to space the camera from the arch. An accurate measurement of scale was made from a 1 m long brightly painted stick hung from the arch. Distinctions between photographs were made with code numbers. The numerals were printed in bold numbers with black marker on white 8½" x 11" paper held up on a clipboard in the picture. Caution had to be used to ensure that the 1 m stick and code number were visible and that the view of the arch was free of major obstructions.

This process was repeated down the length of the gateroad, although a few deviations were made in areas with square set beams and conveyor drives. The closest possible arch to the 50th was taken in this situation.

The crew size varied with the length of roadway being surveyed and the availability of manpower. To complete a short gateroad (under 1500 m) a crew of three was adequate (Table 2). On the way into the face, roadway heights and widths were measured and the arches numbered. Photographic profiles were taken on the way out. When the length to be covered was greater than 1500 m five people were required to complete the survey in one shift. The crew would walk into the gate end and then two members would start taking heights and widths and marking rails on the way out (Table 2). Photos would be taken by the three remaining team members following closely behind. Although the crew size varied, a minimum of three people were required to carry out the survey effectively.

In the older workings of Number 26 Colliery, 7 North Coal and 10 South Material roads, the spacing of the arches was so irregular that intervals of 9 m and 45 m were used to correspond with the rest of the data taken on 10th and 50th arch spacings at 0.9 m centres.

Pictures were not possible for all gateroads monitored because of high gas concentrations in the Number 26, 7 North Coalroad and the Lingan 5 East Material Road.

Booking was best achieved as a separate job in the survey, since with one person responsible for booking the results, the cameraman was free to move about quickly. The same was true for the person measuring heights and widths. A standard survey notebook was used to record the results, the durable paper being particularly useful in the underground environment.

Each day's results were subsequently photocopied on surface to supply a copy for filing.

DATA TABULATION

A 200 mm x 250 mm black and white print was made for each picture and from this a tracing made (Lingan data only). This was necessary to facilitate the use of a planimeter for area determination, because although the print was fairly thin, it caused the planimeter to skip when it came in contact with the edge. On the tracing, a floor line of best fit was drawn between the arch legs (i.e. line of solid floor below accumulated debris that occurs on the sides).

Perimeter was measured by means of a curvimeter (Rolling map measure). For a 2 piece "H" section arch the perimeter was measured from the centre line to the floor on both the gob and solid sides. A 3 piece yielding arch was measured from the top of the side piece to the floor on both the gob and solid sides. Our intention is to use these perimeters in conjunction with the original perimeters (i.e. manufacture - specifications) to determine the floor penetration of the leg.

Number 26 Colliery data was handled slightly differently. White opaque ink was used to outline the arch in the photo and draw in the floor line. To facilitate planimeter use, a sheet of plexiglass 400 mm x 750 mm x 5 mm was placed over the photo and this allowed the planimeter to travel freely over the photo without hitting a ridge. The curvimeter was then used directly on the photo to determine arch perimeters.

The underground data when tabulated in this form gives:

1. Vertical closure,
2. Horizontal closure,
3. Cross-sectional closure,
4. Perimeter of arch above floor.

ROADWAY CLOSURE ASSESSMENT

Roadway closure is affected by many factors including:

1. Method of roadway support,
2. Barrier pillar width,
3. Depth of cover,
4. Geology of roof and floor,
5. Rate of face advance,
6. Pack type and width
7. Extracted seam height.

Information on these parameters was collected from mine and geological plans as well as mine records.

The mine records revealed data on the following parameters:

1. Date and face locations of shutdown,
2. Rates of face advance,
3. Method of stone removal for arching,
4. Arch and pack type with locations of where they were used,
5. Extent and location of remedial work to the roadway.

Information was tabulated from mine and geological plans by Cape Breton Coal Research Laboratory staff. Barrier pillar widths, depth of cover and geological conditions were determined for roof and floor. These parameters were recorded for the same intervals as the photographs (50 arches).

To establish photo location, the length of the gateroad at the time of the observation was determined from mine plans and weekly records of face position supplied by CBDC. Once these parameters had been established, the barrier pillar width was measured for each location.

Horizontal distance was measured perpendicular to the line of the gateroad from outside the ribline of the gateroad to the outside ribline of the gateroad above in the case of a material road, and to the outside ribline of the gateroad below in the case of a coalroad.

The depth of cover was calculated from a mine plan with contours of the sea bed superimposed onto it. At the photo locations, the elevation of the seam pavement was taken. From this figure, the height of coal was subtracted, and the elevation of the sea bed also subtracted leaving a figure

representing the depth of solid rock cover.

Geological information was coded from a 1" - 400' geological plan. For every 10th arch, a 5 digit code was assigned (Table 3). The first digit represents the floor, a "1" representing a soft floor and a "2" representing a normal floor. The following digits represent channel intrusions of the roof. Digits No. 2 and No. 3 were used together to describe channels on the face side of the point being examined. If a channel was within 90 arches of the point (on the face side) the second digit would describe the channel as follows:

3 Defined
4 Probable
5 Uncertain
6 Projected

Digit No. 3 would record the distance between the point being examined and the channel by the number of arches. The number of arches would be rounded off to the nearest 10 and divided by 10 (i.e. 43 arches would be represented by "4").

The 4th and 5th digits were the same as the 2nd and 3rd respectively except they described channels on the face start line side of the point being examined.

DATA ANALYSIS

The data is being analyzed on a Digital Professional 350 micro-computer using specially written software in the Basic language, with data files being prepared suitable for graphical presentation. These files are then transferred via telephone link to a Vax 11/750 mainframe in Ottawa which houses the proprietary package used to prepare graphical outputs. Interactive graphics presentation is performed using a Tektronix 4663 pen-plotter and a Tektronix 4052 micro-computer via the same telecommunications link.

DISCUSSION

1. Results indicate that the photographic technique for recording profiles is simple and fast, allowing a great deal of information to be collected. Not only is the profile recorded, but also the photographs produce a file that can be examined at a later date for information not previously considered (i.e. evidence that an arch is undergoing side pressure from a squeezed pack).
2. A good working knowledge of the photographic equipment is essential in order to recognize problems such as tearing film and photoflash malfunctions.
3. Height measurements are variable due to the nature of the floor, since accumulated debris can be irregular and ballast may have been laid for the track. This may cause variations of between 10 cm and 20 cm, but the number of readings taken will tend to smooth this out.
4. In some of the older workings of Lingan and Number 26, work had to be carried out early in the week; the methane concentration being too high to permit use of the electrical flash after several days of coal production. Since these mines were not operated on the weekends, Mondays and Tuesdays were found to be the best days to work in those areas ventilated with return air.
5. To simplify the coding of photographs, a chalkboard 20 cm x 50 cm would be a useful replacement for the clipboard. This would save printing separate numbered sheets beforehand.

CONCLUSIONS

1. The photographic technique is an effective way of measuring deformation over large distances of roadway.
2. Measurements of leg penetration into the floor are possible using this method.
3. Cross-sectional areas can be readily determined from the photographs.
4. Photographs provide a useful permanent record for future reference.

ACKNOWLEDGEMENTS

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Appreciation is also expressed to the employees and staff of the Cape Breton Development Corporation for their assistance and support of this field activity.

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1. Zorychta, H.; MacFadgen, D.W.; and Smith, Floyd; "Strata control measurements in the Sydney Coalfield"; Proceedings of CIM AGM, Quebec City, April 1966.

2. Whittaker, B.N.; "Recording, treatment and interpretation of roadway deformation surveys"; The Mining Engineer (U.K.), July 1976, pp. 606-617.

3. Cain, P. and Aston, T.; "Detailed back analysis of barrier pillar performance in the Sydney Coalfield, Nova Scotia"; Divisional Report ERP/CRL 84-11(J,OP), February 1984; CANMET, Energy, Mines and Resources, Canada.

LIST OF EQUIPMENT (UNDERGROUND)

1. A Nikonos IVA underwater camera, 35 mm lens with batteries removed,
2. A blitzlichtgerot FC631 explosion-proof photoflash manufactured by Gesellschaft fur Geratebau of Dortmund,
3. Kodak Tri X Pan 400 ASA black and white print file,
4. A 5 m x 25 mm carpenter's tape,
5. A 30 m cloth tape,
6. A clipboard with 7.5 m of light rope attached,
7. Surveying notebooks,
8. 8½" x 11" paper and black marker for code numbers,
9. A supply of white railroad chalk.

Table 1 - List of Equipment (Underground)

3 Man Crew

	On Way In	On Way Out
1st Man	Measure H + W Count Arches	Operate Camera
2nd Man	Take Notes	Take Notes + Hold Flash
3rd Man	Number Arches and Check Arch Count	Hold Code Numbers and Chalk up Arches

5 Man Crew

1st Man	Count Arches, Measure H + W
2nd Man	Take Notes, Number Arches
3rd Man	Operate Camera
4th Man	Take Notes and Hold Flash
5th Man	Hold Code Numbers, Chalk up Arches

Table 2 - Crew Breakdown of Field Work

Example No. 1

2 63 47

2 Denotes Normal Floor
63 Denotes a projected channel, 30 arches away from the survey station towards the face
47 Denotes a probable channel, 70 arches away from the survey station towards the deeps

Example No. 2

1 00 36

1 Denotes a soft floor
00 Denotes that no channels are present within 90 arches towards the face
36 Denotes a defined channel, 60 arches from the station towards the deeps

Table 3 - Geological Code (Examples)

BARRIER PILLAR STABILITY STUDY

MINE Lingan LEVEL #11 CST Material DATE July 4/79

ARCH	HEIGHT	WIDTH	PHOTO	AREA	PERIMETER		BARRIER PILLAR WIDTH	COVER	GEO-CODE	
					solid	gob			floor	sst/ch
#	m	Ft	-	M*M	M	M	ft	M	-	-
500	2.59	12.10	F-11	8.27	3.69	3.69	247	465	1	0000
510	2.78								1	0000
520	2.45								1	0079
530	2.45								1	0078
540	2.53								1	0077
550	2.46	12.00	F-12	8.68	3.64	3.54	240	465	1	0076
560	2.66								1	0075
570	2.67								1	0074
580	2.68								1	0073
590	2.79								1	0072
600	2.69	12.30	F-13	9.10	3.95	3.79	232	465	1	0071
610	2.75								1	0070
620	2.37								1	7070
630	2.62								1	7070
640	2.56								1	7070
650	2.79	12.20	F-14	7.68	4.08	3.89	225	465	1	7070
660	2.56								1	7076
670	2.59								1	7175
680	2.70								1	7274
690	2.75								1	7373
698	2.70	12.10	F-15	8.24	3.76	3.53	202	464	1	7472
710	2.60								1	7571

ARCH = 0 is at the present face

Table 4 - Prepared Data Sheet

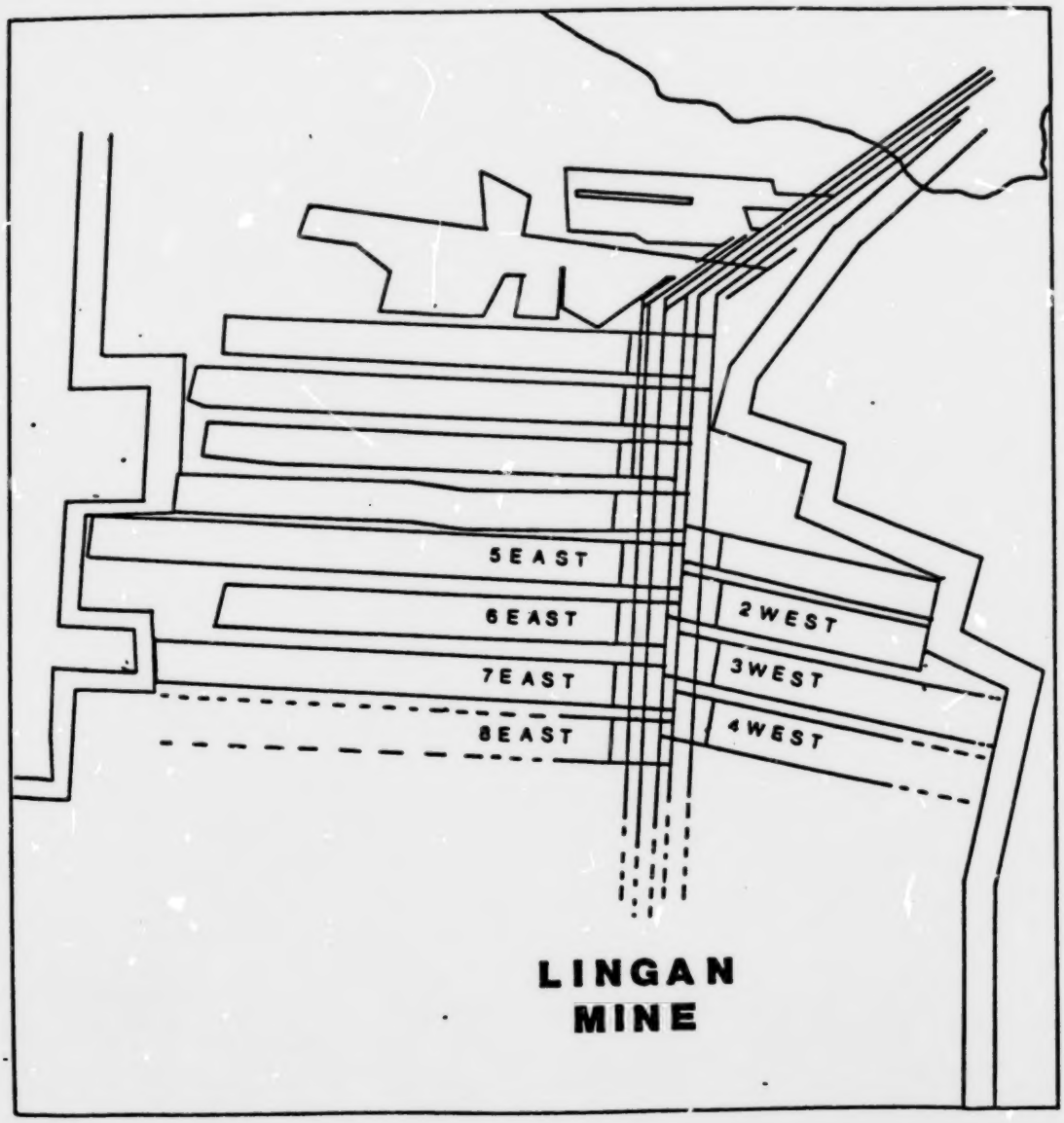
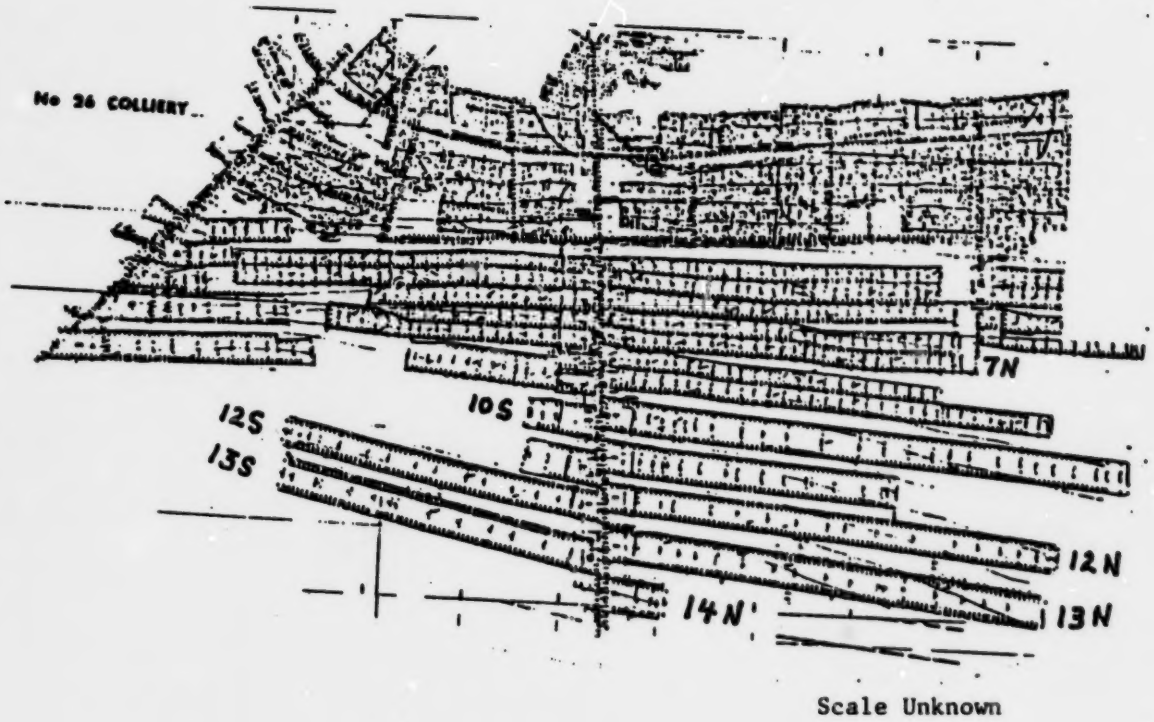


Figure 1 - Sketch - Lingan Mine Workings



Scale Unknown

Figure 2 - Mine Plan of Number 26 Colliery

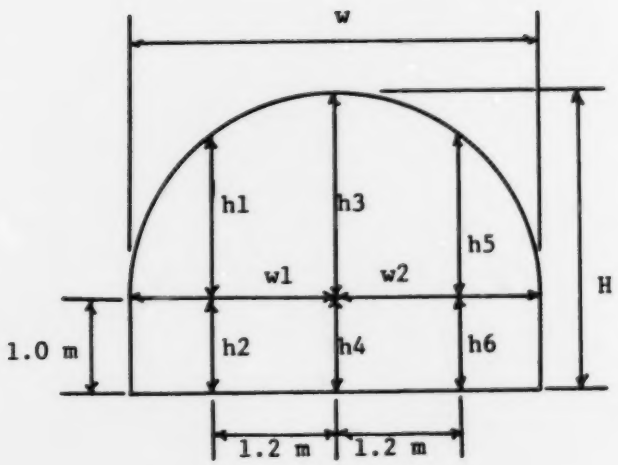


Figure 3 - Record of Roadway Profile (Whittaker)(1)

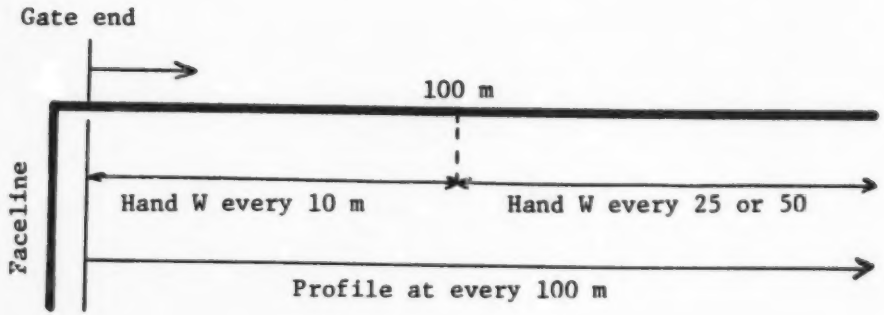


Figure 4 - Frequency of Measurements (Whittaker)(1)

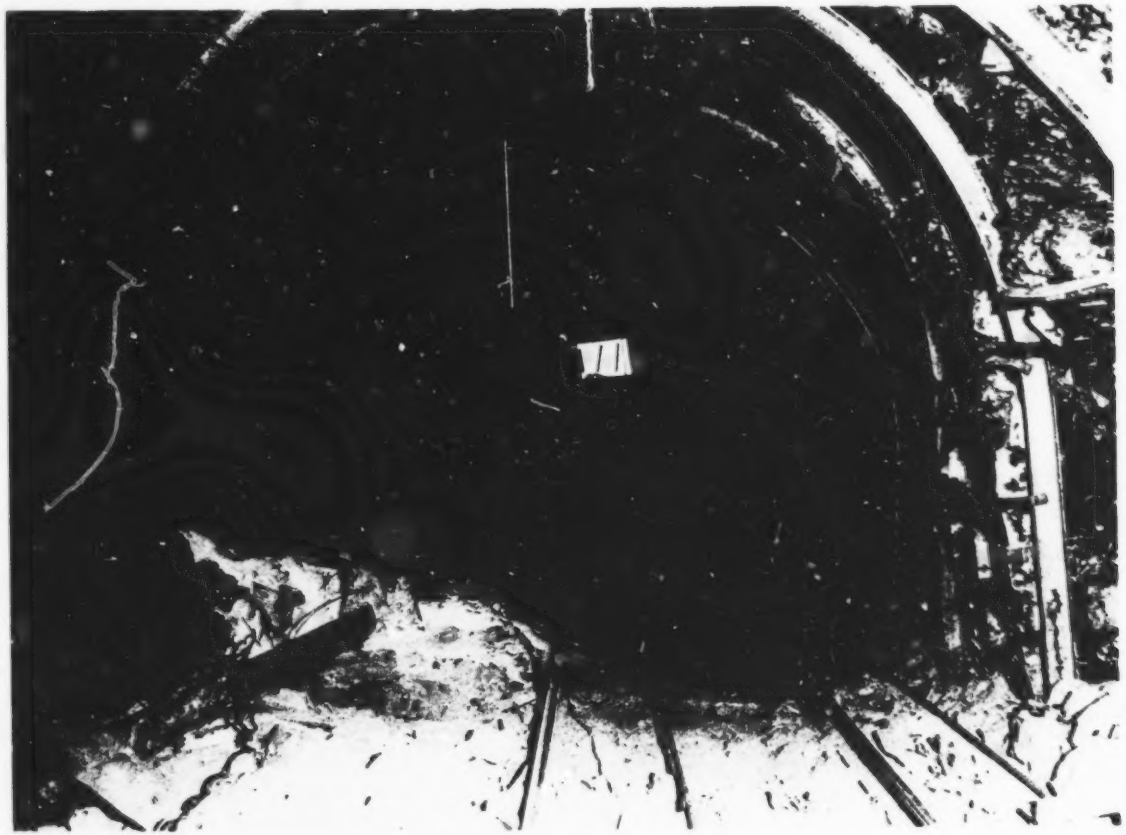
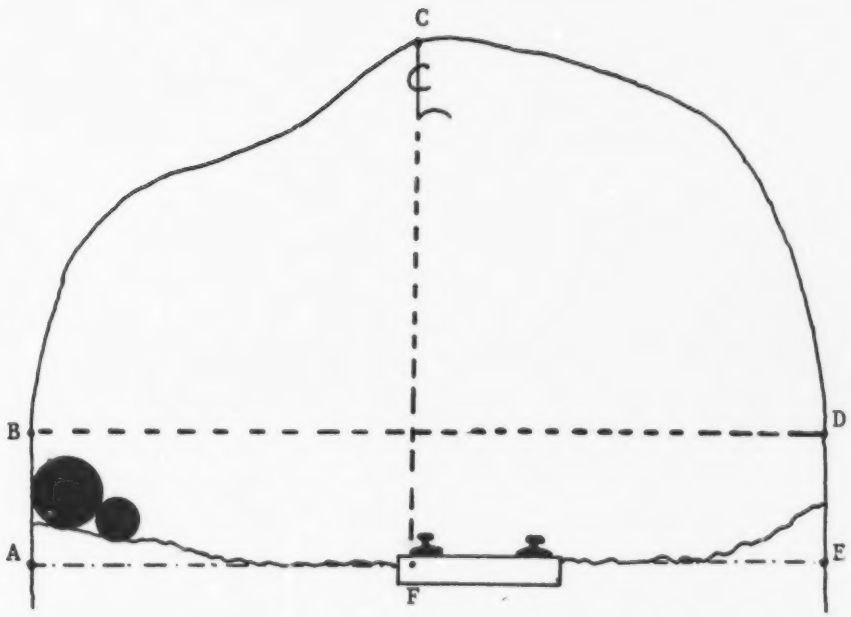


Figure 5 - Photographic Record of Profile



-.-.-. Floorline of Best Fit

B-D Width

C-F Height

C-A Perimeter (Left Leg)

C-E Perimeter (Right Leg)

Figure 6 - Schematic Cross Section of Roadway